The London Air Traffic Control Centre

A report on the largest and most modern air-traffic control complex in Europe, prepared for the Civil Aviation Authority by Laurie Noquet

The Clacton Sector: the Chief Sector Controller (standing right) surveys the traffic being controlled by the eastbound controller (centre) the military controller (left) who is responsible for military operational traffic, and the two westbound controllers (partly concealed by the Chief). On each side are the assistant sector controllers not shown here.

THE efficiency of air traffic control in Britain is something most people largely take for granted. Few realise what a major transformation in the system is taking place and what standards of technical and organisational achievement have already been achieved.

The setting up of the re-shaped London Air Traffic Control Centre (LATCC) at West Drayton, Middlesex, in 1971 has been a major step forward. There the National Air Traffic Services (NATS), now the joint responsibility of the new Civil Aviation Authority and the Ministry of Defence, has created one organisation which is responsible for the majority of civil and military air traffic in and above the airways and in the Flight Information Region over Southern England and Wales extending as far as Birmingham in the north and in the south almost to the tip of the Cherbourg Peninsula.

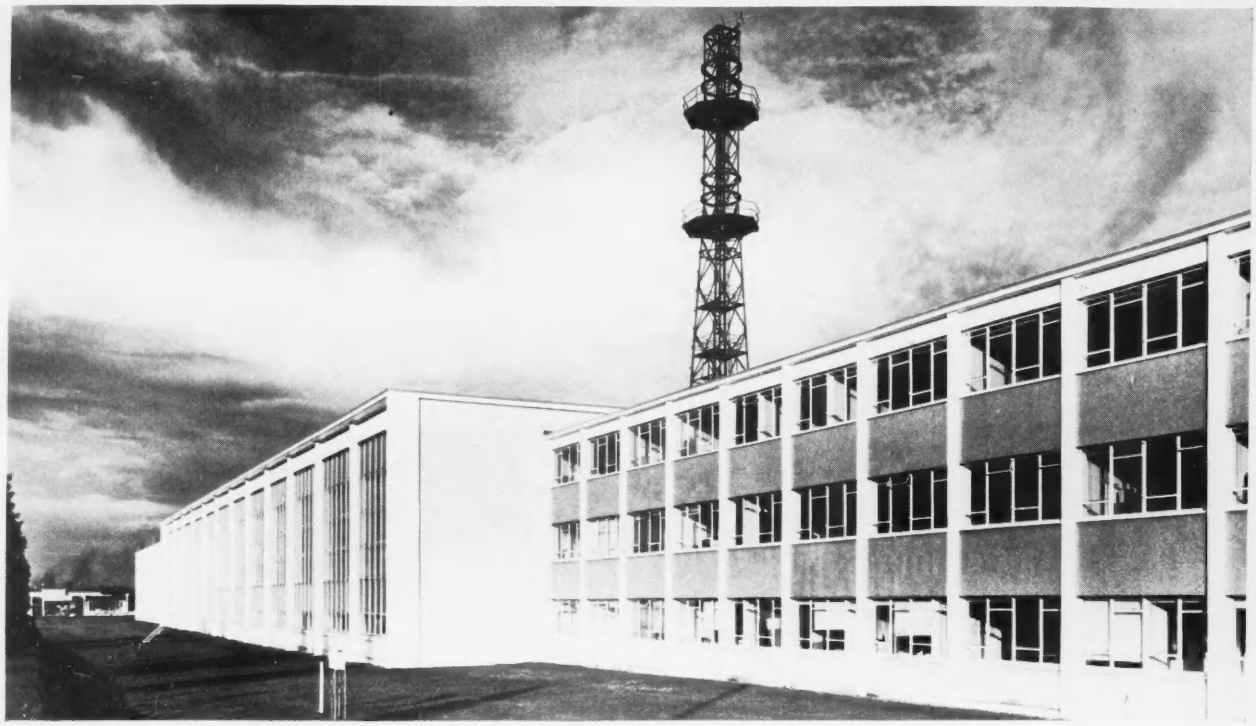
The area for which LATCC is responsible, the London Flight Information Region, will gradually be extended northwards to the Scottish border, so that all air traffic throughout England and Wales will eventually be controlled from this one centre. The UK Emergency Organisation LATCC Distress

A message from Lord Boyd-Carpenter, chairman of the Civil Aviation Authority

THE INTERNATIONAL business of civil air transport exists to serve the public and Britain's new Civil Aviation Authority has been established with this purpose very firmly in mind. One way in which the Authority will serve the travelling public and the industry is through the National Air Traffic Services, for which the CAA has now taken over civil aviation responsibilities and which form a major part of it.

British air traffic control services are held in high regard throughout the world. Proof of this is the fact that each year aviation authorities in some 70 countries send their Air Traffic Control cadets to Britain to study our techniques and eventually to qualify as fully fledged ATC officers. We intend to maintain this reputation; indeed, to do our best to increase it. The Authority will also strive to maintain the high safety standards already achieved by the National Air Traffic Services.

In the new London Air Traffic Control Centre at West Drayton, the CAA staff and their RAF colleagues work together round the clock throughout the year to help the thousands of aircraft, both civil and military, operating in Britain's limited airspace to do so safely, efficiently and economically. Further developments are planned and I hope this report will promote awareness of the vital contribution that NATS is already making.



The London Air Traffic Control Centre at West Drayton, Middlesex.

and Diversion Section has been responsible for this area up to 55°N since 1970.

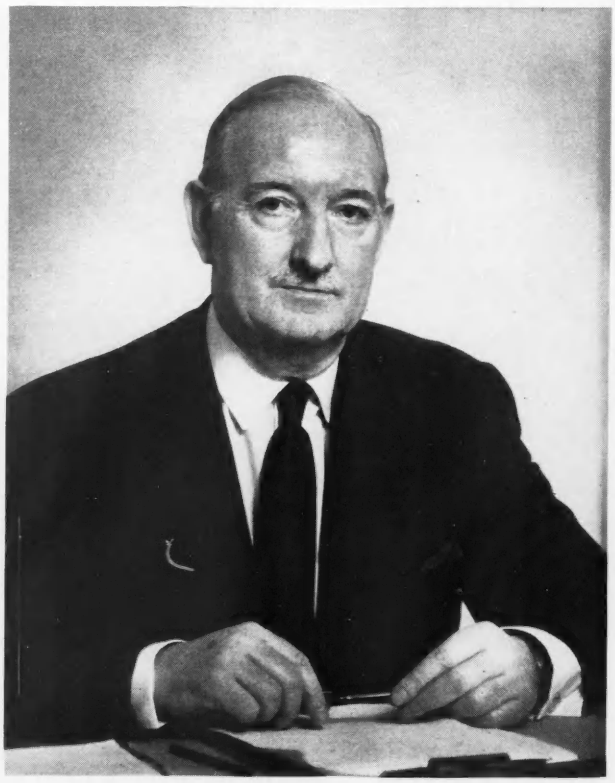
This report describes the services provided for aircraft in the Region and in general terms how they are operated. It describes the way in which the civil and military elements are co-ordinated in practice and some of the developments in equipment which have made this possible.

A problem that has grown fast

During the 1930s there were so few civil flights—sometimes less than one a day—that very little ground control was needed.

It was not until 1952 that the congestion of air traffic flying between major centres, bringing increasing delays and danger of collisions, led to the setting up of an airways system (up to 11,000 ft) between Britain's major airports. Within these airways a system of procedural control was established—that is, control based on pilots' flight plans updated by radio information.

By the end of the 1950s because of the increasing volume and speed of traffic it became clear that a service was required throughout a much greater volume of airspace and that improved radar facilities were essential to enable controllers to offer a radar-based service within the whole of their area of responsibility. It also became clear that control of military



Mr. A. R. Kirk, OBE, Centre Superintendent London Air Traffic Control Centre, joined the then Ministry of Civil Aviation in 1946 following war service 1939-46 with the Royal Air Force. In 1950 he went to the United States of America to study American ATC en route methods during which time he qualified for and obtained a US Air Traffic Controllers Certificate, later playing a leading role in the setting up of the Airways System now operating over the United Kingdom.

Appointed to Ministry Headquarters in 1953, Ray Kirk travelled extensively overseas for a number of years advising and assisting former United Kingdom Colonies in the setting up of their own air traffic control systems. He is well known in international aviation circles having represented the United Kingdom at many ICAO and other conferences in all regions of the world.

In 1963 he became Air Traffic Control Officer-in-Charge London (Heathrow) Airport and when the British Airports Authority came into being in 1966, was appointed Chief Officer, Board of Trade National Air Traffic Control Services, at Heathrow. In June 1969 Mr. Kirk was appointed Centre Superintendent LATCC West Drayton where his immediate task was to tackle all the complex problems associated with the introduction of the Mediator system into operational service. He was awarded the OBE in 1969 for his services to civil aviation.

The Controlled Airspace Operations Room viewed from behind the Supervisor's Desk.

and civil aircraft movements needed to be more closely co-ordinated.

These factors led to the formation of the Joint National Air Traffic Control Service in 1962. By February 1971 co-ordination had reached a point where civil and RAF Air Traffic Controllers sat side by side respectively co-ordinating civil and military traffic over the same area of South East England.

The services provided

Airspace where a compulsory separation service is provided is known as controlled airspace (CAS) and all aircraft within it are subject to instructions from Air Traffic Control. By law such aircraft have to carry the equipment necessary for this control to be effected. At LATCC this is exercised from the Controlled Airspace Operations Room which has combined civil and RAF staff.

Outside controlled airspace a voluntary and therefore necessarily less effective separation service is offered by a number of autonomous radar units some of which have a joint civil/military staff. Responsibility for most of this service will be gradually transferred to West Drayton, the middle airspace responsibilities (8,000 ft.-25,000 ft.) being exercised from the Middle Airspace Operations Room. This room will be staffed by RAF controllers but the service will also be available to civil pilots who wish to make use of it and who carry the necessary equipment. In the upper airspace special rules are in force to ensure that aircraft, both civil and military come under the jurisdiction of the ATC service. The responsibility for this upper airspace service over South East England is already exercised from the CAS Operations Room and this area will be progressively extended as new ground equipment becomes operational. From May 1972 the new organisation is to be fully operative over South East England and will be progressively expanded to include the whole of the South of England and Wales up to 53.00N (a line running just north of Birmingham.)

LATCC also offers the pilots a comprehensive information and advisory service and a further service that no pilot hopes he will require—that of the Emergency Organisation with its attendant search and rescue service based at Edinburgh and Plymouth. All these are round the clock services relying on the most advance electronic equipment—costing more than £35 million. They also rely on LATCC's highly skilled Telecommunications Staff who maintain and adapt it to the needs of Controllers.

Each day the lives of thousands of people and aircraft worth a great many million pounds (a jumbo jet costs £10½ million, a Concorde £12½ million) therefore depend on successful co-operation between the Civil and Military Air Traffic Control staff and the Telecommunications staff. The day by day direction of the LATCC operation rests finally on the shoulders of three men: the Centre Superintendent Ray Kirk, OBE; the Chief Telecommunications Officer (Airways Services) Ted Graham, MBE, and Group Captain Keith Crosby, RAF, the Officer Commanding LATCC (Military).

Controlled airspace

The airways system

To achieve a safe separation of aircraft and to ensure that they reach their destinations with as little delay as possible aircraft are channelled along 'corridors' known as airways which connect major airports. Aircraft navigate along these routes by means of radio beacons, which come under the operational control of LATCC and they are obliged to carry equipment which makes each of them readily identifiable to air traffic controllers. They also need to be able to communicate on the appropriate radio channels. Controllers can then give the instructions necessary to ensure that aircraft are separated by a safe distance—not less than five nautical miles horizontally or a thousand feet vertically.

(*continued on page v*)

S654 the clutter clear air traffic control radar

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The air routes are generally ten miles wide and have a ceiling of 25,000 feet. Above them a network of routes exists in the Upper Airspace. The maximum height of the 'floor' of air routes is 8,000 feet. But since the object is to give protection from take off to touch down the 'floor' descends gradually as routes approach major airports. In the London terminal area (TMA) by far the most congested in Britain the whole airspace is controlled.

Within the Controlled Airspace Operations Room at LATCC the order and precision of the Air Traffic Control operation is immediately impressive. In spite of the fact that anything up to 150 aircraft at any one time—some travelling close to the speed of sound are within the region—there is no fuss and no rush.

How control is organised

Controlled Airspace in the London Flight Information Region is divided into seven sectors. Five of these are 'en route' or journeying sectors and two are terminal sectors which cover the six principal airports. Each of these sectors is controlled by a team of seven.

It is a fundamental principle that no aircraft may enter the airspace of any sector unless its entry is previously co-ordinated by the sector it is coming from. The aircraft must also comply with any condition the receiving sector lays down.

The sectors

The terminal sectors are responsible for aircraft arriving at and departing from the six principal airports in the London Terminal Area (TMA). When because of pressure of traffic inbound aircraft cannot immediately be directed to an airport they are fed into one of the six holding patterns or 'stacks' (based on radio beacons which act as a marshalling point) and descend in sequence. The bottom levels in these patterns and the approach path to the runway are normally controlled by the aerodrome of destination, the upper levels by the TMA Controllers.

'En route' sectors are responsible for the Airways and the associated Upper Air routes in their respective areas, and for traffic crossing these routes.

The sector teams

Each team is led by a crew chief who manages sector operations, arranges transfer of traffic with adjacent sectors, and oversees the whole traffic situation. He also makes sure that traffic is within his team's capacity and restricts it if the number rises too fast. It is a task which calls for skill and experience.

His team consists of four sector controllers who arrange the separation of aircraft and two assistant sector controllers who liaise with adjacent sectors and centres such as Paris, Amsterdam and Brussels to ensure that there is correctly planned separation between flights when they are transferred to another control centre. Operational military aircraft are controlled by the RAF officer on the team.

The entire operation is supervised by the Watch supervisor, a Senior Air Traffic Control Officer, who leads a team of around 80 Controllers and 60 Assistants. As LATCC provides a 24 hour service there are four such teams. which together with the management and other staff make a total ATC workforce of over 600.

A highly trained profession

Each civil air traffic controller has to be a master of his subject. Training is rigorous. Each one has had to pass an intensive three year course at the College of Air Traffic Control, or has had extensive aviation experience and specialised training. During training controllers are made thoroughly familiar with every aspect of Air Traffic Control and they qualify as pilots themselves so that they know what conditions are like at the other end. As new aeroplanes and new techniques come into service their training is constantly refreshed. Military controllers receive equally rigorous training at the Royal Air Force Central Air Traffic Control School.

But for all their training the controllers are utterly dependent upon the quality of their equipment and the vigilance, engineering skill and ingenuity of the 400 Telecommunications staff who maintain it and operate the various telecommunications services.

On a console in front of each sector team all the means are provided which enable controllers to do their job.

The astonishingly rapid advances that have been taking place in recent years in the electronics industry are reflected in the Operations Room (and even more convincingly in the Equipment Rooms) in a most dramatic way.

Radar

Gone are the days when the controller necessarily had to sit in darkness peering at radar screens upon which 'blips', often not easy to identify, made their appearance. The CAS Operations room at LATCC is now well lighted. In front of the ATC teams are 'Digitrace' displays (made by Plessey Radar Limited) which are similar to 22 inch circular television screens. Upon these the bright spots showing aircraft positions are clearly visible in daylight and each is accompanied by a numeric label which indicates the aircraft's identity and also gives the aircraft's height and route. The displays also show the position of radio beacons and the boundaries of the airways system on an electronic map. The controller therefore always knows where every aircraft under LATCC control is and what it is. He can thus see how each aircraft fits into the overall flight pattern and where necessary can direct pilots along a safer path.

Advance information

However, controllers cannot afford to wait until they see on their screens that two aircraft are likely to collide! Warnings

(*continued on page ix*)

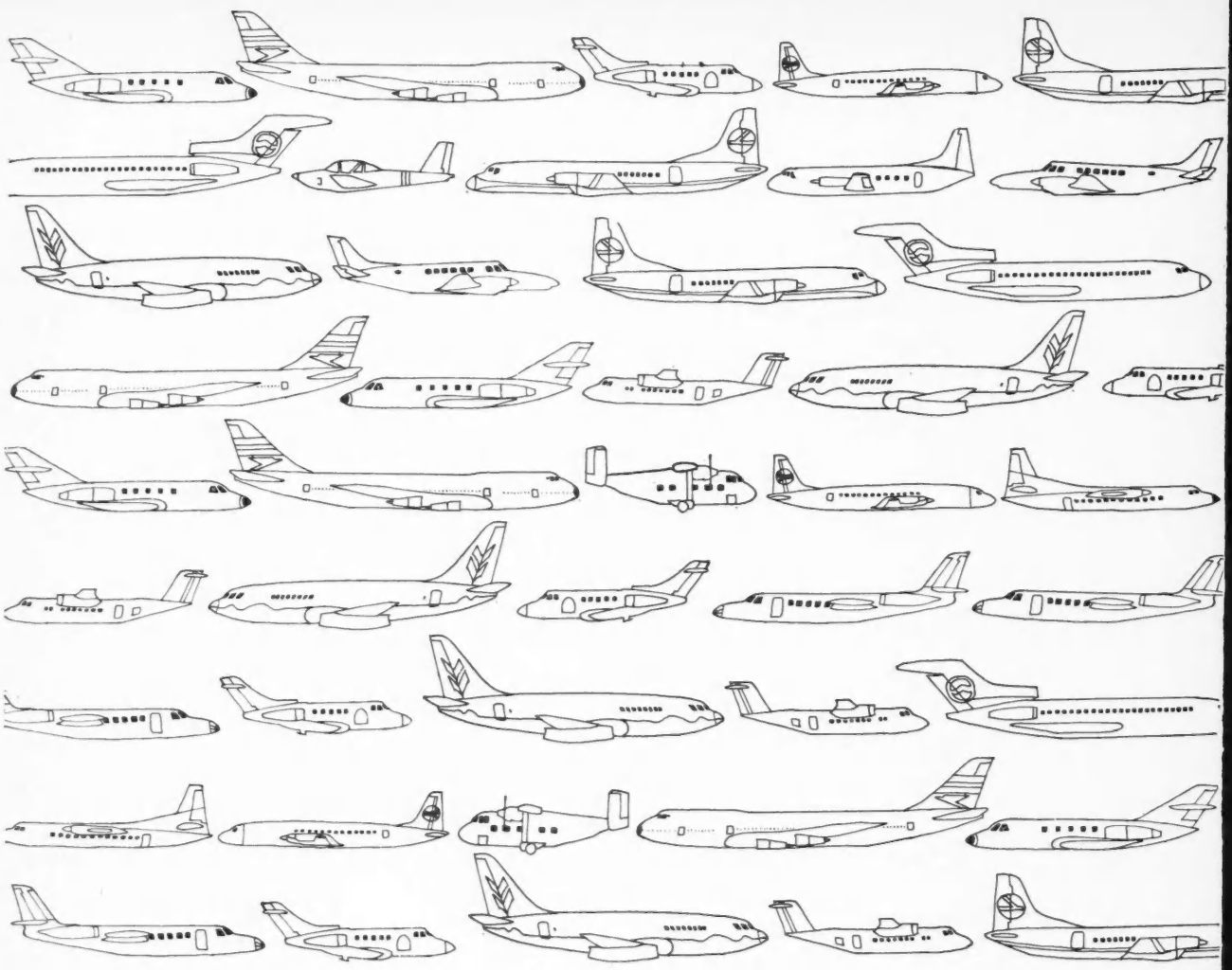
LONDON A.T.C.C.

ANNUAL RECORD OF AIR TRAFFIC MOVEMENTS

	CIVIL				MILITARY				CIVIL & MILITARY				GRAND TOTAL	
YEAR	AIRWAYS - & ADR	%	F.I.R.	TOTAL	AIRWAYS - & ADR'S	%	F.I.R.	TOTAL	AIRWAYS - & ADR'S	%	FIR	%	AIRWAYS - ADR-FIR	%
59	227078	—	54785	281836	37216	—	1192	38408	264294	—	55977	—	320271	—
60	268237	+18·1	64674	332911	37501	+0·7	1259	38760	305738	+15·7	65933	+17·7	371671	+16·0
61	305346	+13·8	65272	370618	35157	-6·3	1674	36813	340503	+11·4	66946	+1·5	407449	+9·6
62	305184	-0·5	60277	365461	36507	+3·8	2122	38629	341691	+0·3	62399	-6·8	404090	-0·8
63	323088	+5·9	63815	386903	36508	—	2456	38964	359596	+5·2	66271	+6·2	425867	+5·4
64	349636	+8·2	62092	411728	36090	-1·0	1888	37978	385726	+7·3	63980	-3·5	449706	+5·6
65	375044	+7·3	63691	438735	31241	-13·4	2306	33547	406285	+5·3	65997	+3·2	472282	+5·0
66	433794	+15·7	63509	497303	30245	-3·2	2668	32913	464039	+14·2	66177	+0·3	530216	+12·3
67	489653	+12·9	67397	557050	35082	+15·9	3189	38271	524735	+13·1	70586	+6·7	595321	+12·3
68	477743	+6·0)	60975	538718	44654	—	5767	48421	522397	—	64742	—	587139	—
69	497447	+4·1	67595	565042	51251	+14·8	4780	56031	548698	+5·0	72375	+11·8	621073	+5·6
70	566041	+13·8	66767	632808	54448	+6·2	4533	58981	620489	+13·2	71300	-1·5	691789	+11·4
71	623882	+10·2	76040	699922	47790	-12·3	4563	52353	671672	+8·2	80603	+13·0	752275	+8·7

A revised method of counting was introduced in 1968, therefore % comparison over 1967 not entered.

The last column shows that air traffic has more than doubled since 1959.



Because it's busy up there

Crowded skies mean crowded days for people involved in air traffic control.

Ferranti have done a lot in ATC.

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Years of work in related fields, including naval and military digital systems.

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And we can offer measureable reliability because we've had systems in operation long enough to quote you MTBF and MTTR figures.

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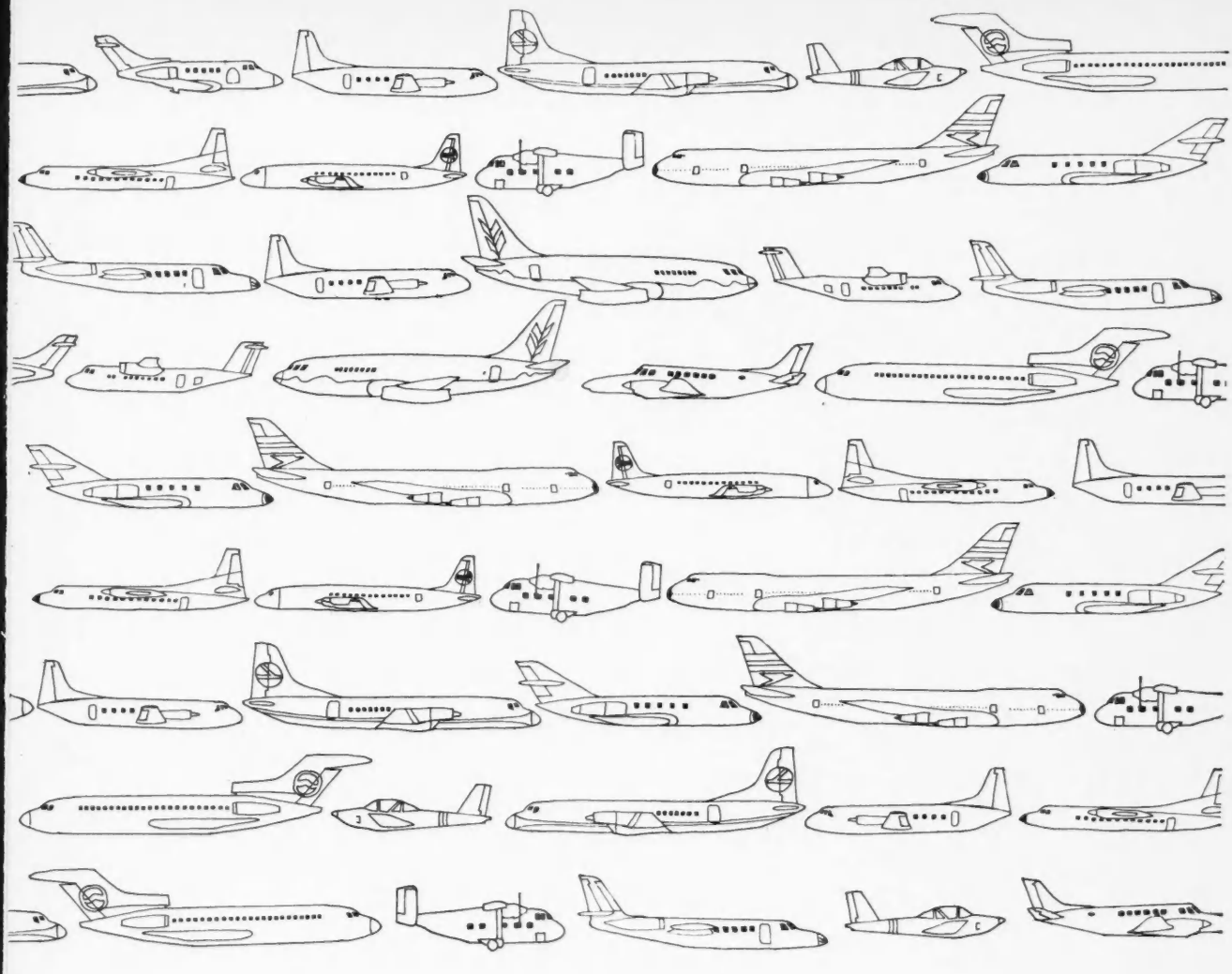

we're busy down here.

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Kastrup Airport, Copenhagen
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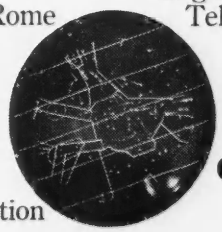
Heathrow Airport, London
Simulator for familiarisation



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IT WORKS

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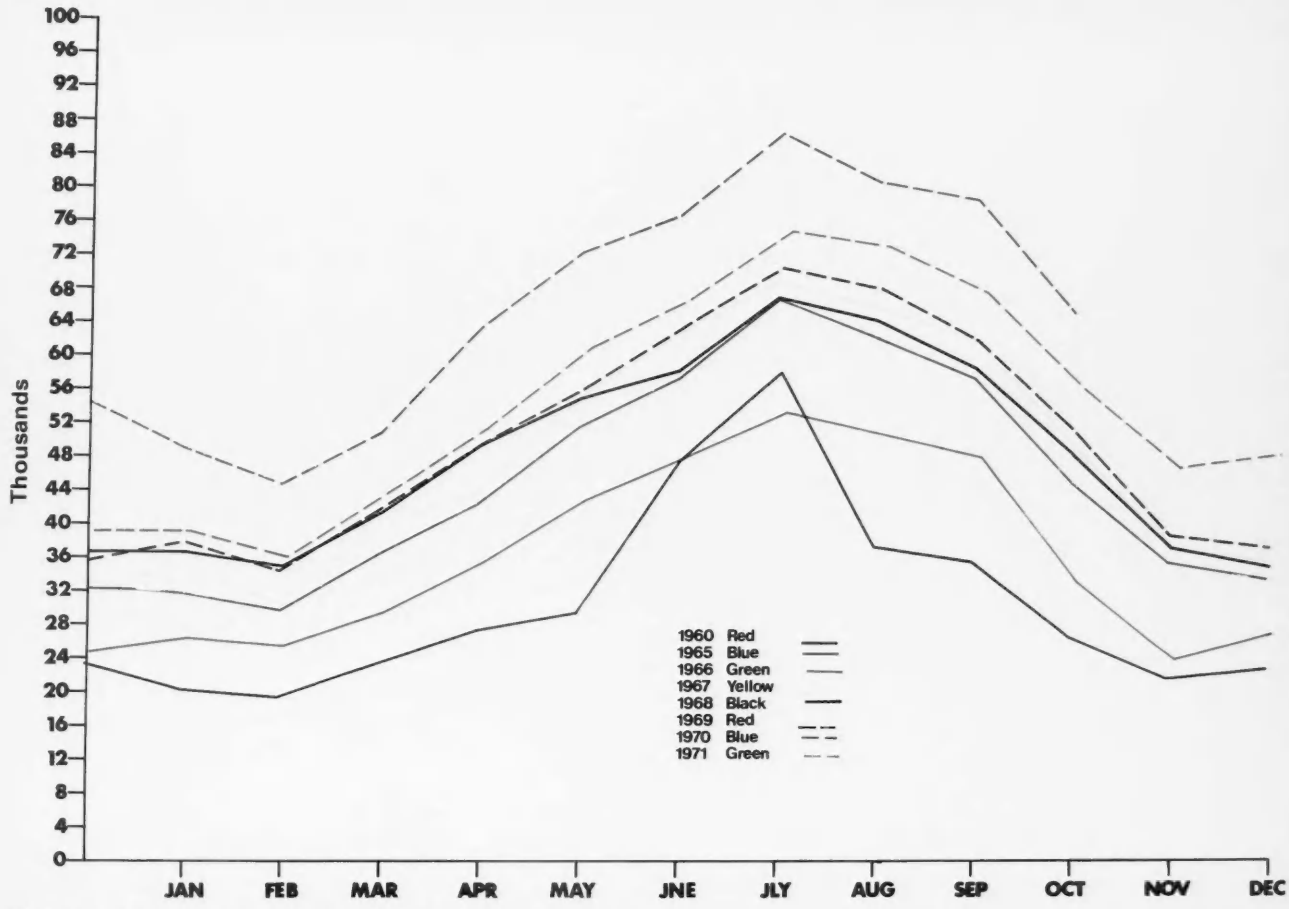
LONDON AIR TRAFFIC CONTROL CENTRE —— MOVEMENTS



NOTE. A revised method of counting was introduced in 1968.

about corrections to route or height must be given to pilots in good time. Each controller knows well in advance the essential information about aircraft that will enter his sector. Displayed upon his console are flight progress strips which indicate for each flight the call sign, radar code, aircraft type, speed, point of departure, destination and predicted time at particular points.

A strip is printed giving this information on every aircraft for each reporting point in its journey. They are arranged in geographical order on the console and can be amended as more up to date information is received. This information is essential for the controller to be able to plan ahead a safe route and height for the pilot that involves the least possible inconvenience for him. It also enables separation to be achieved even if there is a radar failure.

Communications

Equally essential for the controller is his ability to be able to speak to aircraft within Controlled Airspace anywhere from off the Irish coast to the North Sea.

There are up to 30 RT Channels immediately available to each controller to speak to aircraft and at any one time a Controller can select two of these.

A private automatic telephone exchange at LATCC installed and maintained by the Post Office, and operated by NATS enables each Controller to talk to his colleagues and links him directly with the national and international ATC telephone systems. He can thus be in immediate contact with his opposite number in the French centre in Paris and similar centres elsewhere.

At the top of his console are closed circuit television (CCTV) screens each displaying by selection one of four sets of information providing him with additional facts he needs—for instance the weather, the state of radio and radar facilities and traffic arriving at or departing from Heathrow Airport.

Also displayed electronically in front of the Controller is information on visibility at the two main Heathrow runways.

A typical controlled flight

This example describes a flight from London to Amsterdam. First, the pilot files his flight plan at Flight Clearance at Heathrow and this is fed directly into the Flight Plan Processing System (FPPS).

Strips are printed out for each of the control positions which will deal with the flight and are distributed to the Assistant Controllers concerned. When the passengers are on board, the pilot requests taxi clearance from Aerodrome Control and moves toward the runway. The Aerodrome Control Assistant allocates a four number radar code which is passed to the pilot and then telephones details of the flight to LATCC. There an air traffic control assistant who is monitoring the Aerodrome Control radio channel passes the information to the outbound controller by closed circuit television.

The outbound controller's assistant selects the strip on the aircraft from the pending display and places it in front of the controller.

When the aircraft takes off, the airborne time is displayed on the CCTV by the monitoring assistant enabling the outbound

(*continued on page xii*)

Air Safety reflects advances in ATC

Air traffic is increasing. So, fortunately, is the development of automated air traffic control systems. During the next few years, air safety must depend on how well ATC keeps pace with aviation progress and the corresponding increases in traffic density.

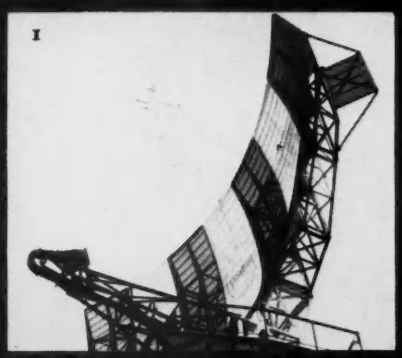
The Plessey contribution is to provide the air traffic controllers with the tools to enable them to continue with their efficient tasks.

These tools may be complete operational complexes like MADAP at Maastricht in Holland or MEDIATOR at West Drayton in England, or automated secondary radar systems, or primary and secondary radar heads, display and data processors for larger or smaller ATC systems, instrument landing systems . . .

The common denominator is the long and specialised experience of ATC requirements that Plessey brings to the task of meeting today's and tomorrow's needs.

ATC requirements vary from country to country, from airport to airport, from airfield to airfield. Plessey manufactures a comprehensive range of equipment and systems; and its experience, at all levels, in most parts of the world, also means that Plessey is well placed to advise its customers on their ATC needs.

...reflects equipment progress by Plessey



*The **AR-5 23-cm air surveillance radar** (1), designed to handle current and projected airliners (including SST's) from take-off out to 200 n.m., complements the well-established AR-1 S-band radar which*

*is installed on large and small airports throughout the world. The **ACR430** (2) provides the smaller civil or military airfield with an inexpensive but versatile and high-performance radar; its twin-beam system*

*caters for a very wide range of operational tasks. '**Digitrace**' daylight viewing screens (3) make their own unique contribution to air traffic control, by way of unambiguously displayed data and reduced controller fatigue.*

PLESSEY RADAR

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Loading flight progress strips automatically into holders. This machine, specially evolved for LATCC by S. Davall & Sons Ltd. cuts sheets of flight progress strips printed by the Hermes computer into individual strips and loads them into plastic holders at a rate of 40 per minute.

controller to identify the radar echo as it leaves the runway. It also enables the Clacton assistant sector controller to update his FPPS strips and to compare this flight with others in the sector and allocate the cruising level.

The outbound controller, having asked the pilot to set his radar code, separates him from other traffic in the terminal area, starts him on his climb and telephones the Clacton controller responsible. Transfer of control takes place when the Clacton controller has identified the flight in question and climbing clearance is given to the allocated cruising level. By this time the Assistant Controller has telephoned Amsterdam with details of the flight and when the aircraft is at its cruising level clear of other traffic and past the English Coast control it is transferred to Amsterdam's air traffic controllers.

Outside controlled airspace

The service

The main aim of LATCC (Mil) outside Controlled airspace is to make the service to pilots as comprehensive as possible: first of all within the middle airspace and then those parts of the lower airspace that are within radar cover. (Lower airspace is space below 8,000 ft. and is now to some extent covered by aerodrome radar units). But this service will be dependent firstly on the amount of information LATCC can get about aircraft within the region at any particular time and secondly on control capacity.

Priority must go first to pilots who wish to cross the crowded air routes and after this to those who need a separation service climbing from or descending to busy aerodromes. If after satisfying these requirements there is spare capacity it will be at the service of pilots who are simply flying within 'uncontrolled' airspace.

Organisation

The overall smooth operation of all aspects of LATCC (Mil) services under the direction of the Group Captain commanding will be the responsibility of a Wing Commander with experienced Squadron Leader supervisors covering the individual sections or Operations Rooms.

The MAS Operations Room

The MAS Operations Room is a bold concept. Not only is the organisation new but major parts of the equipment are radically different from that used elsewhere. The radar displays themselves are Marconi fluoride vertical ones although they have secondary radar labels with coded information about aircraft flight level, etc, as in the CAS Operations Room. But the Electronic Data Display (EDD) and the 'touch wire' system planned for introduction in 1973 are both entirely new.

By means of the EDD the information which each controller needs to know about every aircraft of concern to him can be displayed at his operating position in abbreviated form. This information is similar to that which in the CAS Operations Room is detailed on flight progress strips.

The principle of the touchwire display/control system was one of several electronic inventions in the field of Air Traffic Control which originated at the Royal Radar Establishment, Malvern

Group Capt. K. B. Crosby, RAF, the Officer Commanding LATCC (Mil), has been in the Royal Air Force since 1942 seeing war service in North Africa and in the Middle East. He has held various posts as Senior Air Traffic Control Officer and staff appointments at Group, Command and Ministry of Defence level. An Associate Fellow of the Royal Aeronautical Society and a Member of the Chartered Institute of Transport, he graduated at the RAF Staff College at Bracknell in 1955. He was a founder member of the Guild of Air Traffic Control Officers, of which he was Master in 1964.

Keith Crosby has been associated with the planning of the Mediator Project since 1961 when he became the military member of the facilities group at the Royal Radar Establishment Malvern. Various posts in the planning organisation led to him becoming Project Co-ordinator for the RAF which post he relinquished in March this year to take responsibility for the military aspects of the LATCC.

Worcs. Marconi was one of the companies awarded the licence to develop operational equipment. The Marconi system, the most advanced in Britain—if not the world—heralds a new generation of direct input devices for use with computer-displays.

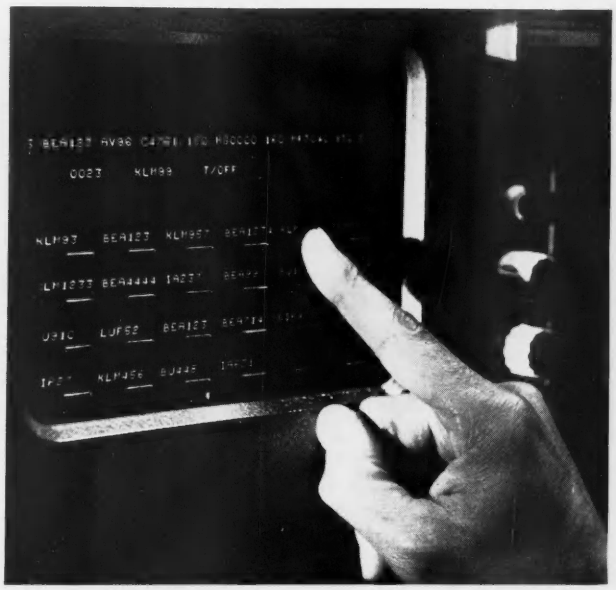
By means of a touchwire labelled with the call sign of each aircraft under his control the controller can select for his touchwire display the information he needs about any aircraft. When he needs to update this information, for instance as a result of RT Communication with pilots, he can do so by means of touch wires (arranged similarly to the keyboard of a typewriter but under computer control and infinitely variable).

The Myriad Computer Complex, which backs up this equipment immediately updates the data storage information on the aircraft and automatically changes the information shown on the electronic data display.

Flight plans

Pilots who wish to make use of the MAS radar service will need to file flight plans except in the case of requests for airways crossings. Most flight plans are likely to originate at aerodromes or at en-route ATC agencies (when plans are filed during flight). From there they will be teleprinted or telephoned to LATCC (Mil) Main Flight Plan Reception Section. However, a pilot who has not previously filed a flight plan before take off or whilst en route will still be able to file it by R/T direct to the MAS Operations Room.

It is the task of the Flight Plan Reception Section to convert Flight Plans into a form in which they can be fed into the Myriad Computer Complex (the Flight Plan Processing System) which processes them for Electronic Data Display.



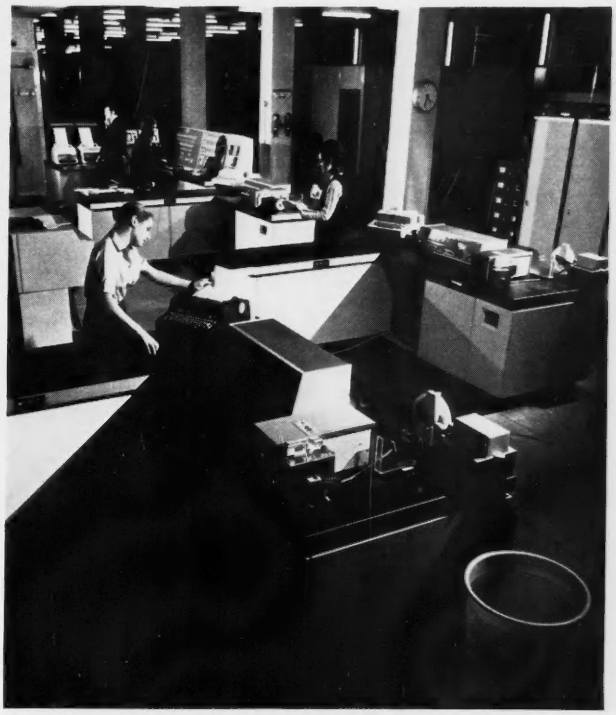
Touchwire displays provide a unique method of communication with a computer system, enabling an operator to 'converse' with the computer through an infinitely variable keyboard, related directly to the output display. The operator is seen here instructing the computer to provide additional information on a particular flight (KLM99), selected from a list of aircraft under air traffic control. The touchwires can be seen as short lines under each of the lists of flight numbers in the lower half of the display. In addition to supplying touchwire displays for the new London Air Traffic Control Centre, Marconi has supplied them to Eurocontrol, for an experimental control centre near Paris.

Other services

Flight information

Comprehensive information services providing almost any information they require for the safe conduct of their flights

MAS Stage 1 Operations Room. RAF Squadron Leader (left) and his two colleagues during a system evaluation exercise, are assessing the controllers' new tools of trade in the MAS Operations Room which is due to become partly operational on May 15, 1972.



This computer room will form the heart of the Myriad Flight Plan Processing System (FPPS), one of the most advanced systems of its type in the world and well ahead of any comparable system in Europe when it goes into operation next year.

This massive, computer controlled system is based on a triplicated Marconi Myriad I computer complex made to handle flight plans and control data for all aircraft under air traffic control in the middle airspace in the southern half of the country. The Myriad computers will automatically process the vast quantity of traffic information in a fraction of the time required by previous methods and eliminate a vast amount of manual calculation.

Over 200 man-years of computer programming have gone into the very comprehensive software back-up to this system in which not only is failure almost completely eliminated, but the speed of operation is such that the most complex instruction is carried out in less than three microseconds.

D and D (Distress and Diversion). The Flight Lieutenant (left) is one of the two Emergency Controllers on duty, each with an assistant, in the D and D Room, the hub of the Emergency Organisation at LATCC. He is handling an aircraft in distress in the Liverpool area. The aircraft's position is indicated on the Auto-triangulation Display by the white cross at the point where all the cathode ray direction-finding bearings from some of the 18 remote slave stations meet. The controller's assistant marks the spot (white cross) with an electric marker gun.

are available to both civil and military pilots—information on the state of aerodromes, the availability of navigational aids, etc. As the needs of military and civil pilots are sometimes different teams of civil and military ATC staff are available in the Flight Information Section. Essentially a task of providing information on request, FIR Controllers do monitor published frequencies, receive position reports and provide limited information on the presence of other aircraft known to be in the area.

Weather

LATCC provides to aircraft a continous broadcast of weather information relating to the principal airports in this country and on the Continent. The necessary weather data is received on teleprinters throughout the Meteorological Operational Telecommunications Network Europe. Special recording equipment is used to pre-record and continuously transmit this data. Information is updated by special operators every half hour. This service operates 24 hours a day.

Equipment Maintenance Control Air-Ground-Air Communication—Within this technical area are contained the communication sub-systems. The engineering staff are responsible for the maintenance of this equipment and advising System Control of the current state of the services. The equipment in the background is the Multi-carrier Station Remote Control Equipment (MSRCE) made by Plessey Radar Limited, providing comprehensive control and monitoring of the transmitters and receivers at the remote radio stations.

Distress and Diversion

Perhaps the most dramatic of the services provided by LATCC (Mil) is that given by the Distress and Diversion (D and D) Section which plays a key role in the UK Emergency Organisation. It is the nerve centre of the constant guard which is maintained over the entire country and adjacent sea areas up to 55°N (a line just north of Newcastle upon Tyne) to give immediate assistance to aircraft in distress. Scottish ATC centre at Prestwick provides the service north of 55°N.

The emergency controllers and their assistants monitor the international VHF and UHF R/T Emergency Frequencies and on the latter use auto-triangulation to ascertain immediately the position of any aircraft in difficulty. Auto-triangulation is a remarkable, indeed spectacular, method of instantly pin-pointing on a 3 yards square map of the United Kingdom and its immediately surrounding seas, the spot where a military aircraft may be in difficulty. Should the aircraft crash, ditch in the sea, or have to be abandoned by its crew this last known position information may be vital to the ensuing search and rescue action.

This service needs to be instantaneous since the lives of passengers and crews may depend on how swiftly the D & D Section at LATCC can direct help to the area which is identified by signals transmitted from the special remote forward relay direction finding (D/F) radio stations in the surrounding countryside. These are received at LATCC (Mil) by apparatus in a room at the rear of the map and appear on the map itself as brilliant green lines intersecting centrally at the point where the aircraft's last signals were heard, thus enabling the D & D staff to alert the nearest rescue services within seconds of the information coming upon the map.

This auto-triangulation system is another entirely British development pioneered about 15 years ago by Standard Telephone and Cables at New Southgate. It has subsequently been extensively developed and has been well proved in operational service. At LATCC it now offers a nationwide coverage from some 18 remote stations giving a precise and reliable position fixing service.

The controllers can select facilities at any of their remote radio stations to establish and maintain communications with the aircraft in trouble. Their Post Office landline telephone facilities are comprehensive and flexible to give them rapid

contact with controllers at the majority of military aerodromes area radar units, adjacent air traffic control centres and rescue co-ordination centres. Up to date weather information, and aerodrome and approach aid serviceability states of some 60 aerodromes are continuously maintained for visual reference and immediate use by the controllers alongside their auto-triangulation display.

Primary and secondary surveillance radar information (explained below) from various national primary or SSR heads is being made available for use by the emergency controllers to assist them throughout the handling of incidents. In particular, automatic aural and visual warning devices will alert them to those aircraft which carry transponders (explained below) selected to SSR codes to indicate that they are in difficulty. Not all aircraft, of course, carry SSR transponders and for this reason the basic auto-triangulation system, with 'operational control' being transferred to the appropriate area radar or approach radar unit will continue to be used as the basic and well established technique for handling emergency incidents.

Auto-triangulation is a life saver

As an example of the work done in the Distress and Diversion section the following extracts from the official report on one of a number of these incidents speaks for itself.

At 1453 hrs on February 9, 1971, a speechless code signal (used in the case of microphone failure) on frequency 243.0MHz was heard in the Distress and Diversion section at LATCC (Mil). Using the auto-triangulation system, a fix was obtained in a position 4 nautical miles north of Linton-on-Ouse, Yorkshire. Flying Officer Alan Nuttall, the Distress and Diversion Supervisor, immediately replied to the call using several forward relays (remote radio stations), but was unable to make contact with the pilot and correctly assumed the aircraft's receiver (as well as his microphone) to be unserviceable.

Flying Officer Nuttall instructed his Distress and Diversion team to contact Northern Radar, Leeming Approach Control and Northern Maritime Rescue Co-ordination Centre (RCC) and to ask Linton-on-Ouse for a 'shepherd' aircraft (i.e. one that could escort the stricken aircraft safely back to a suitable airfield). Northern Radar reported that there were many aircraft in the area of search which made identification difficult, but by use of the height finding equipment they had eliminated the upper and lower height bands and were concentrating on the medium height band.

Leeming Radar reported that they were observing on radar an aircraft which appeared to be flying a left-hand triangular pattern (the international emergency signal for aircraft in difficulty having both radio transmitter and receiver unserviceable). On receiving this information, Flying Officer Nuttall transferred operational control of the 'shepherd' aircraft to Leeming Radar for directing towards the speechless aircraft. The pilot of the shepherd aircraft made visual contact at 11,000 ft. with the speechless aircraft, at 1513 hrs identifying it as a Jet Provost 22 minutes after the initial speechless code signal was originated.

'Through the able direction of Flying Officer Nuttall, the excellent teamwork of his deputy and assistant and the co-operation of Northern Radar and Leeming Radar controllers, the shepherd aircraft was able to escort the Jet Provost to Linton-on-Ouse—its parent station—where it landed safely at 1530 hrs.'

Flight Information Service—in the foreground the civil controllers and their assistants, with their military counterparts on the right. These teams have available or have access to all the information required by aircraft in flight and also provide pilots with information concerning traffic operating outside controlled airspace.

How the information gets to controllers

Telecommunications

The new LATCC at West Drayton is a major engineering achievement, representing the results of many years of detailed engineering work in transforming the operational requirements of Air Traffic Control into technical sub-systems and equipments. In integrating the various equipments into an overall system, not only was it necessary to ensure provision of a reliable and effective service, but it was important that the engineering design should permit a continuous and evolving development of facilities and equipment to serve ATC for many years ahead. By close co-operation between NATS Telecommunications Engineers and the British Electronics Industry, maximum possible use has been made of the most modern technology in the design and engineering of the centre.

The whole engineering enterprise is one which reflects great credit upon the imagination, skills and resourcefulness of the many engineers involved from various organisations including NATS Telecommunications Headquarters and Engineering Establishment, the Department of Environment, the Post Office and the many Companies who have provided the equipment and assisted with the detailed engineering.

The telecommunications organisation

All the Telecommunications installations both at West Drayton and the various dispersed radar and radio stations (there are 30 such stations) providing facilities for both civil and military controllers at LATCC comprise the Telecommunications Airways Services Group. Its Headquarters is located at West Drayton. The various Telecommunications systems providing the 'ears' and 'eyes' for the controllers are not only extremely sophisticated, being probably the biggest concentration of complex electronic systems in the country, but have to be completely reliable. Considerable attention is given in the design, installation and maintenance of the various systems by Telecommunications Engineers to ensure the highest possible degree of engineering reliability. Within individual sub-systems there is a deliberate measure of redundancy and standby capacity.

Naturally the staff have to be trained to the very highest standards, the professional engineers being educated to degree level and the technical officers are also required to hold high technical qualifications. An improved system of technical

(*continued on page xvii*)

Amplivox Minilite. Untouched by human ear.

New Minilite weighs a mere 50g. Yet it combines maximum operating efficiency with absolute wearer comfort.

With Minilite, Amplivox have avoided the problems of the old fashioned ear plug insets through ingenious use of an adjustable earpiece. An acoustic tube with sibilant filter replaces the heavier and more familiar boom microphone. Pressure pads are out too, instead there is a non-metallic headband with special bars that give stability without uncomfortable pressure.

Specified for Eurocontrol, Minilite is being widely used in air traffic control, aviation and communications control as well as other branches of industry. Minilite is, undoubtedly, the headset of the seventies. It's just one of the wide range of high-quality specialist products for civil and military use from Amplivox. No-one else offers so much for so little.

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RACAL
The Electronics Group

The aerial system of the S264A 50cm surveillance radar equipment made by Marconi Co. Ltd. It is 9½ tons in weight and revolves at 5¼ or 10½ revolutions per minute. This radar has a peak power output of 500kW and a range in the region of 200NM. This particular installation is situated at Heathrow Airport and is used by the sector controllers at LATCC, West Drayton.

education has recently been introduced whereby new technical staff do a three year apprenticeship at the Civil Aviation Training Establishment at Bletchley while studying for the National Certificate in Engineering; but their education does not finish there. When new techniques or equipment are introduced they return to College or the manufacturers for further intensive training.

The overall minute to minute control of all Telecommunication Services is exercised by the System Controller (a Senior Telecommunications Technical Officer), who working in close co-operation with the ATC Watch Supervisors (both CAS and MAS) directs the maintenance and operation of Telecommunications services to ensure that they are deployed to meet the needs of Air Traffic Control at all times.

Mr. G. E. Graham, MBE, Chief Telecommunications Officer, Airways Services Group, joined the Ministry of Civil Aviation in 1946 following Army service as a Lt.-Col. with the Royal Signals, being awarded the MBE in the North African and Italian Campaigns.

In 1953 Ted Graham became the first Superintendent of the Civil Aviation Communications Centre in Croydon, moving in 1955 to Heathrow Airport as Senior Telecommunications Officer. In 1962 he was appointed Superintendent of the Telecommunications Engineering Establishment and four years later took over responsibility at national level for Telecommunications maintenance policy and operations.

In 1970 he became CTO of the Airways Services' Group, which embraces LATCC and the various radio and radar stations that serve it and was responsible for the final commissioning of all the Telecommunication Facilities associated with Mediator Stage 1.

Radar services

The radar information which feeds the screens in front of the Controller is gathered from widely distant parts of the large area covered by the London Flight Information Region. There are stations at Heathrow Airport, Ash near Canterbury and Ventnor in the Isle of Wight. To extend the area of coverage stations will also be brought into service for LATCC at Clee Hill in Shropshire, Burrington in Devon, St. Annes near Blackpool and St. Mary on the Scilly Isles. Each of these stations, with the exception of the Scillies, will be provided with primary as well as secondary radar. The main function of primary radar is to give aircraft position. Secondary radar in addition indicates their identity and height. Primary radar detects aircraft by transmitting pulses of radio energy which are reflected from aircraft back to the radar receiver. The echo from the aircraft appears as a bright spot on the radar display and indicates its position.

Secondary surveillance radar (SSR) depends on equipment carried by the aircraft (a 'transponder') which receives pulses from a ground 'interrogator' and automatically transmits return pulses. Each pulse from the 'interrogator' is accepted by the 'transponder' in the aircraft where it responds in code back to the 'interrogator'. The coded information is displayed to the controller in a form which indicates the identity and flight level of the aircraft. Transponder equipment is now an international requirement for aircraft flying in Upper Airspace and most of Controlled Airspace and legislation will eventually make the fitting of modern and comprehensive transponder equipment compulsory in all aircraft flying in airspace where a mandatory ATC service operates.

Primary radar signals are now fed from the radar stations over Marconi multiplex broad band microwave links. The SSR information is converted into digital form and is transmitted by these same links using three slots in the base band or as a standby by Post Office landlines. Radar techniques are continually developing and with the newest equipment being installed at Burrington (Plessey Plot Extractor Type PCD)

both primary and secondary radar information will be converted into 'digital' form and can thus be passed by telephone lines to LATCC. This not only eliminates the high maintenance costs of the radio links but obviates the environmental problems of siting link stations and makes possible the interchange of information between control centres. At the Centre the information in this form can be fed directly into a computer for processing and presentation on the Controller's display and can also provide other facilities for future ATC requirements. This system will be extended to other remote radar stations.

Primary and secondary radar systems are largely independent until the information reaches West Drayton. The

A telecommunications engineer is checking the performance of a Scan Converter. This equipment is used to produce a television type radar presentation which can be viewed under reasonably high ambient lighting conditions compared with conventional radar display arrangement which have to be observed in a darkened environment.

combination of these signals to a high degree of accuracy is a considerable feat of electronic engineering.

In the CAS Operations Room Plessey 'Digitrace' equipment (using Scan Conversion) provides radar display as a television type picture which can be read without difficulty in comparatively well lit surroundings. Special video map generators (provided by the Solartron Electronics Group) produce on the radar display the electronic outline of the Airways System. This television scan is approximately equivalent to a 1,000-line television picture. The Scan being essentially a digital one enables the primary signals to be 'interrupted' and thus allows the numeric SSR labels to be displayed.

In the MAS Operations Room more conventional Marconi radar displays are operated under lower lighting conditions. Nevertheless facilities are still provided for the interruption of normal primary radar displayed to present on the viewing Unit appropriate SSR labels.

In October last year H.R.H. the Duke of Kent, who had expressed a wish to see the London Air Traffic Control Centre, was shown round by Mr. W. C. Woodruff, Joint Field Commander NATS (left). Mr. Ted Graham is seen here (right) explaining a radar display to the Duke.

Flight plan data processing services

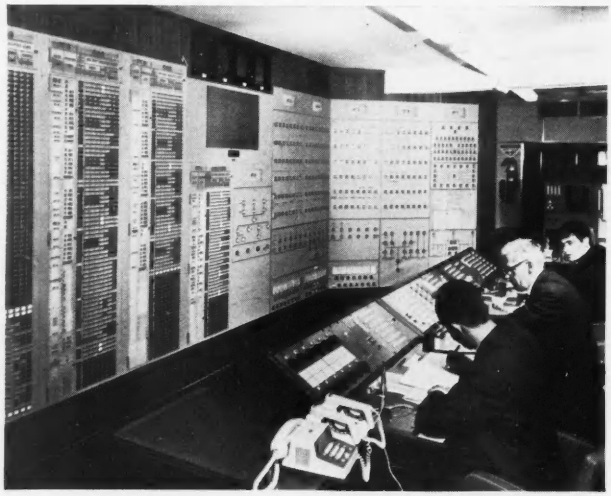
To type the information flight progress strips for the 3,000 aircraft under LATCC's Control during peak days would need an enormous team of typists. To calculate their arrival time at different points would need at least as many arithmeticians. Fortunately the job is done more quickly more cheaply, and more accurately by computers.

As already mentioned two different flight plan data processing systems are provided at LATCC. One system already in use provides services to the Controlled Airspace Operations Room whilst the other, due to become fully operational early in 1973, will provide a service to the Middle Airspace Operations Room.

Controlled airspace

In controlled airspace a system based on a Ferranti 'Hermes' Computer (with a 32,000 word store) is used as a means of printing flight progress strips.

The central processor of the computer is programmed to contain data on the structure of the airways, the link routes within the London Terminal Area, and on reporting points and distances between them and the Heathrow runways in use. It



Telecommunications System Control. The engineers in this room are responsible for the overall control and deployment of the telecommunications facilities in order to meet the moment to moment requirements of air traffic control and for controlling and co-ordinating all fault restoration and maintenance activities. The large indicator panel presents the detailed serviceability state of the electronic systems.

can also accept up to date data on the wind at various heights. With all this information it can process flight plan data for each flight. It prints out well in advance a flight progress strip for each reporting point at which the aircraft should make contact with ground control.

The details of flight plans for aircraft other than Heathrow Departures are received by telephone or teleprinter at West Drayton and are entered into the system by teleprinter operators. Heathrow departure traffic is entered at the airport itself over a special data link to the processor at West Drayton. Special arrangements are also provided within the system to deal with regular flights which are registered with LATCC as such by the airlines. These arrangements avoid the need for the airlines to file individual flight plans for each such regular flight.

This computer system also provides basic data on all flights, which are then used as a means of calculating the charges to be made to airlines and other users for the air traffic services provided.

The middle airspace system

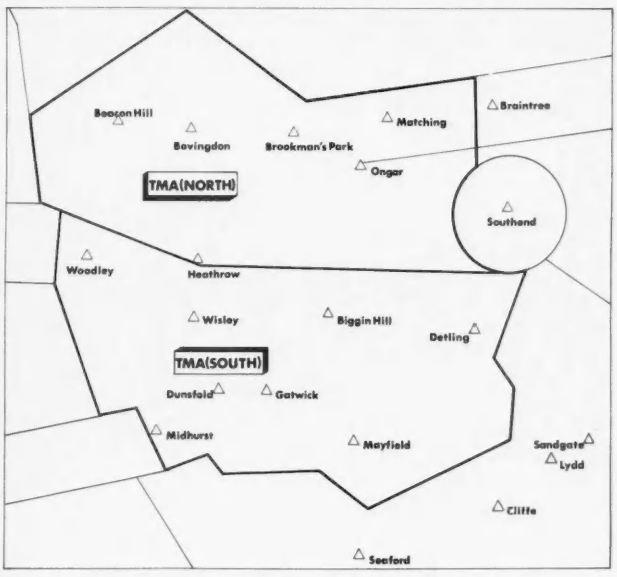
For the Middle Airspace Operations Room a Marconi Myriad Computer Complex will process the Flight Plan information and Controllers' amendments to this through the Touchwire System, for display on the Electronic Data Displays. Besides these, other equipments will enable the computer to operate teleprinter and line printer services and it will be able to exchange information with other centres.

To achieve the utmost reliability the overall system consists of three separate computer complexes which each carry out identical processing of data. These three elements of the system normally cross-check the results of their processing and the overall control of the system is undertaken by one selected computer complex. In the event of the failure of one, or even two of these elements of the system an operational service can still be maintained.

Each computer is provided with 36,000 words of 'fast access' storage and each is backed with disc storage equivalent to 2 million words. These discs retain a record of all events processed by the computer.

Communications

Controllers are able to speak to the aircraft by means of 15 remotely controlled radio stations that are strategically placed to give complete coverage throughout the London Flight Information Region. These stations consist of separate transmitter and receiver sites and contain VHF and UHF equipment and are connected to LATCC by Post Office landline. Remote Control Units enable complete technical control and monitoring of the services to be exercised from LATCC. The system at LATCC can expand to handle up to more than 100 RT channels and to serve more than 500 operating positions.



TMA Sectors have responsibility up to 13,000 feet in this area.

Equipment Maintenance Control (Radar). The engineering staff here are responsible for the maintenance of the radar processing and display systems; for control and co-ordination of all radar systems, and for advising System Control of change, or proposed change of state of any of these services.

An entirely separate distribution system providing certain vital Radio Telephone (R/T) channels at each sector within the Operations Room is also available in case of failure. All RT conversations and some telephone ones are continuously recorded. These recorded conversations are normally retained for 30 days although they may be held longer when they are needed for investigations.

Britain ready for the future

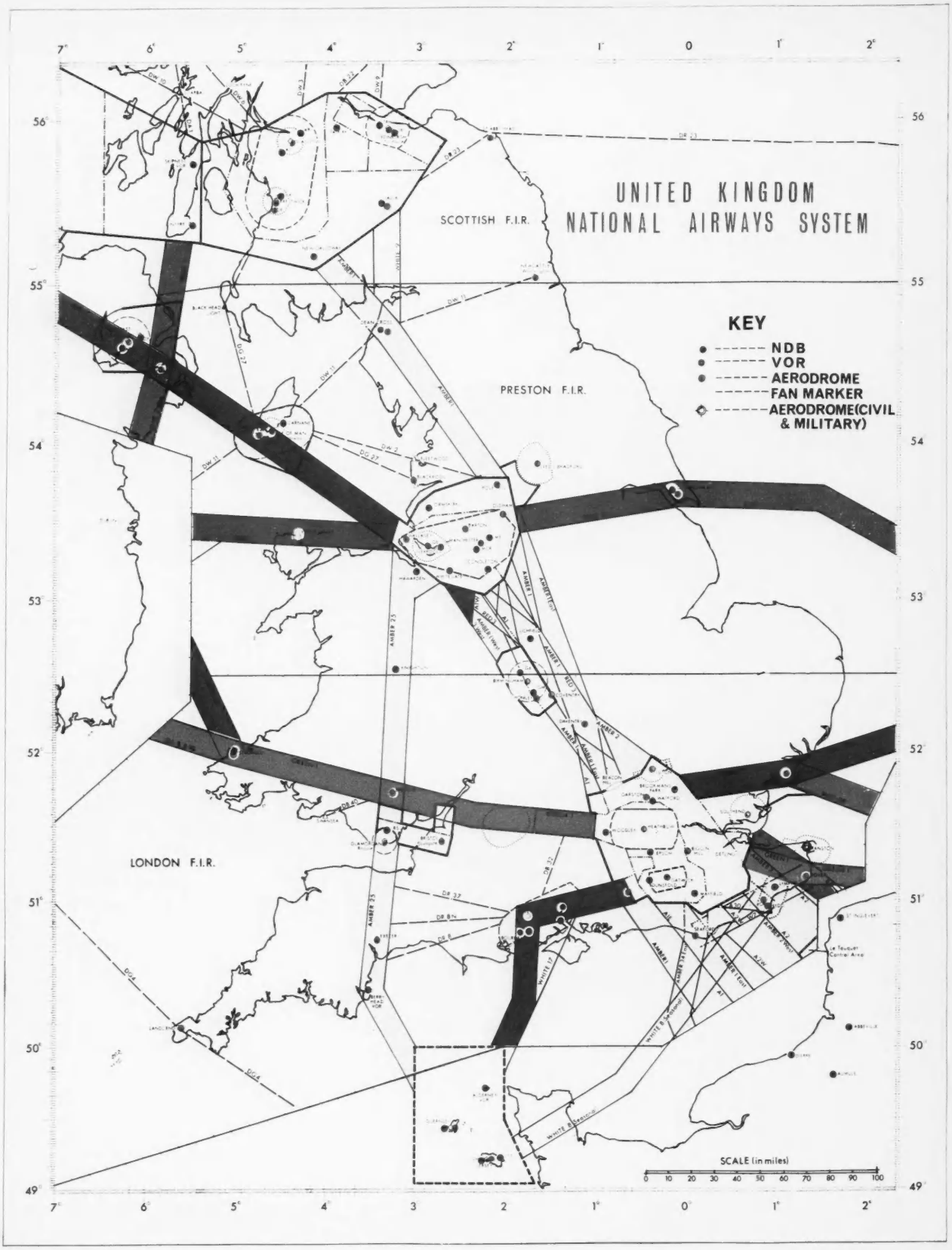
The immense joint civil/military operation now in being at the London Air Traffic Control Centre for all its expertise and modernity is a continually evolving system in which much new technical ground has been broken. What has been described above is the culmination of many years research and planning by NATS Headquarters ATC, Operations and Engineering staff, by the ATC Evaluation Unit at Bournemouth, the Royal Radar Establishment at Malvern and the many parts of the electronics industry. It is an operation which the new Civil Aviation Authority intend to go on improving wherever opportunity offers. This very month (May 1972) the Middle Air Space Control Room goes into its first stage of operation. Throughout the next decade other areas of the country will be brought into the system until in the end most of the airspace of Britain up to the Scottish border will be controlled from West Drayton, whilst a new air traffic control centre organisation to cover the airspace northwards will be set up at Prestwick in Scotland.

This evolutionary process will enable the control organisation to maintain with far greater ease the safe and smooth flow of traffic over the United Kingdom in spite of steadily increasing numbers.

A map of the United Kingdom National Airways System is shown overleaf.

Copies of this report may be obtained from the Information and Publicity Section, Civil Aviation Authority, 129 Kingsway, London WC2 6NN. The Authority wishes to thank the following for their co-operation in the provision of photographic and other editorial material:

British Insulated Callender's Cables, British Airports Authority, DTI Photographic Unit, Ferranti Digital Systems, Forman House Public Relations, John Lawrence (photographer), Marconi Radar Limited and Plessey Radar.



VOR is the primary navigational facility in the United Kingdom and is the International Civil Aviation Organisation's (ICAO) standard short range navigational aid. VOR (VHF Omnidirectional Range) provides an unlimited number of legs (called radials) and has a range of 150 to 200 miles. The VOR operates by transmitting in all directions two separate signals at the same time, one being unchanging, the other varying with change of position round the VOR transmitter. NDB (Non-Directional Beacon) is used to mark airways or air routes and as an approach and landing aid. Fan markers are now used (like a milestone) to indicate positions along an airway, regardless of the aid being used to keep the aircraft on the airway.